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Succulent Feeds for Dairy Cows In Summer



Cutting a field of soybeans. This shows the growth that can be secured and the soybeans make an excellent feed.

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

C. F. Curtiss, Director

ANIMAL HUSBANDRY
DAIRY HUSBANDRY SECTION

Ames, Iowa

SUMMARY

From the results of the trials reported here it is possible to make some quite definite recommendations.

1. The use of either corn silage or soiling crops solves the dairy cattle feeding problem which accompanies the short pastures of summer.
2. Even tho silage is generally preferred because of a less amount of labor required, soiling crops are adaptable to many conditions. This is the situation when the herd consists of too few cows to justify a silo or when a tenant has no silo on the farm.
3. With a partial soiling system, such as was employed in the experiments, three-fourths of an acre can furnish the succulence for a cow during the summer season at one-half or less the cost which would be required by the use of pasture alone. This plan is of great value to the man who has no silo or very valuable land or only a small farm.
4. The success of a soiling system depends largely upon the yield of feed that can be secured from the crops. Judgment in selecting crops to use and care in growing them determine the yields.
5. A complicated system of crops that entails more than six different special seedings is not practicable.
6. The use of the regular farm crops, such as alfalfa and corn, at the proper time during the season greatly simplifies the system.
7. Amber cane and the oat and Canada field pea mixture are the best special soiling crops for Iowa. If circumstances warrant it, the peas may be omitted and the oats used alone, or the amber cane may be mixed with soybeans or cowpeas.

SUCCULENT FEEDS FOR DAIRY COWS IN SUMMER

BY H. H. KILDEE, EARL WEAVER, JOHN M. SHAW AND FORDYCE ELY.

THE IMPORTANCE OF ROUGHAGES

Profits in dairy operations are determined largely by the roughages available on a dairy farm. Successful dairymen plan feeding practices according to the roughages they have at hand. The kind and amount of grain they feed depends upon the roughage, being employed largely to supplement any possible deficiency in the roughages.

There are two reasons why dairymen build the ration around the roughages: (1) The dairy cow is adapted by nature to the consumption of bulky feeds. She utilizes such feeds more efficiently than do other kinds of livestock and for the sake of greatest economy, she must be so fed as to take advantage of her particular adaptability along this line; (2) Roughages generally are cheaper sources of nutrients than are concentrates because they are home grown feeds that sometimes have very little, if any, marketable value.

Thus, good feeding practice calls for concentrates only when the roughages are limited in quantity or quality, or when the cow produces so abundantly that she cannot secure sufficient nutrients from the roughages alone to meet her demands.

SUMMER PROBLEMS

The roughage problem for summer feeding is just as important as for winter, but it is more commonly neglected. Most cows invariably decrease in production during the hot dry season from the middle of July until the end of August. This decrease can be attributed to a number of causes. First, fall freshening cows are approaching the end of their lactation periods and can be expected to drop in milk flow. Flies generally annoy the cows badly at this season as does also the hot weather, but the chief cause for the drop in production is the feed shortage which accompanies dried pastures. Most Iowa pastures get quite short and dry when hot weather comes and frequently their supply of feed is inadequate for the milking herd. To add to this difficulty, many farmers are busy harvesting and making hay at this season and are likely to neglect their cows. But the observing dairymen appreciate the seriousness of a reduced feed allowance at any season and take steps to avoid it.

METHODS OF SOLVING THESE PROBLEMS

In order to reduce summer losses in production to a minimum, any of the following five plans can be employed.

1. Larger pastures.
2. Better cultural methods for pastures.
3. More concentrates.
4. Summer silage.
5. Soiling crops.

Pasture is frequently considered a cheap feed. This is true if it is on land that is too hilly or rocky to cultivate. But with 85.5 percent of its area in improved farm land, Iowa has very little waste ground and a large acreage of pastures is on expensive land upon which taxes, interest and the upkeep of fences are considerable. An average pasture supports only one cow for every two or three acres. It is obviously not in line with efficient dairying to employ any more of such expensive pasture land than necessary.

The second alternative in maintaining summer production is to improve the pastures now in use. Good cultural methods can be as profitably employed in the pasture as on any part of the farm. Liberal applications of manure improve the pastures. Manure can be spread at any time except when the ground is soft and even during the pasture season it does not cause the cows to refuse the grass.

Some reseeding of suitable grass mixtures early in the spring is also profitable. Discing the pastures is beneficial, especially if the disc be weighted heavily and set quite straight. It penetrates the sod, admits air to the roots and allows moisture to enter. It also scatters droppings so that the spots of large grass do not appear and remain uneaten.

A common injury to pastures results from turning the cows out too early in the spring. Temptation to do this is great because spring farm work has started, pastures are growing and the feed supply may be low. However, grass contains an excessive amount of water at this time and affords very little feed. Pasturing grass off short early in the spring also reduces its yield for the rest of the year. Probably the worst result from turning onto pastures too early is that the tramping of the cows kills out considerable grass and allows weeds to appear because the ground is soft at this time. In Iowa it is better to hold the cows off the pasture until May 1 most seasons. All these suggested plans improve the cover of grass and reduce the weeds. In late July or August, the mower can be used in the pasture to kill any remaining weeds before they go to seed.

These practices can help greatly in prolonging the pasture season, but even then the grass dries up and the cows suffer unless supplied with additional feed.

If a dairyman finds himself confronted with dried up pastures and has no other substitute, he must feed grain extensively. Grain is expensive, but its proper use is more economical than to allow the cows to drop excessively in production and to lose weight until they become unthrifty. The proper procedure is to prepare in advance for this expected feed shortage.

The provision of succulent feed to supplement the pastures is the best precaution. This feed can be either summer silage or soiling crops. The use of either embodies the features of intensive agriculture wherein the greatest possible yield is secured from a given area but, of course, more labor is thereby entailed.

The purpose of the experimental work reported in this publication was to determine which plan can best solve these summer feeding problems.

CHOOSING BETWEEN SILAGE AND SOILING

Investigators quite generally agree that silage is more desirable than soiling crops. The American dairyman farms too extensively and his labor is too expensive for him to become enthused over soiling crops. In Europe, however, where land areas are limited, where pastures are frequently not available and where labor is cheap, soiling systems are attractive. At the Iowa station McCandlish (30) found that silage was worth 75 percent more per ton than soiling crops for feeding dairy cows, but that when the corn price is below \$1.00 a bushel, silage is the more economical.

Woll, Humphrey and Oosterhuis (46) of the Wisconsin station found corn silage more desirable than soiling crops. They secured a greater yield of silage per acre and a much lower labor cost. At the Nebraska station, Frandsen (11) also reported better results with silage, which silage produced butterfat at a feed cost of 21.5 cents per pound while the cost when soiling crops were used was 24.5 cents. The labor in producing milk was found by Frandsen (12) to be 25 to 30 percent less when silage was fed as compared to soiling.

That it is even preferable to grow clover and either oats, rye or wheat for ensiling in June rather than to depend upon soiling crops is the conclusion of Daniels (8) of Massachusetts, while Doane (10) found rye soilage greatly inferior to silage.

In New Jersey, Billings (4), and Lane (23) and (24) favored soiling crops rather than silage, but their investigations involved the use of silage in winter and soiling in summer. Seasonal influences undoubtedly affected their results. Billings (5) and (6) later says that silage is of equal value with green wheat, buckwheat, millet and corn for summer use.

On the basis of investigations at Kansas, Otis (34) concludes that "On account of the difficulty involved in harvesting soiling

crops, the silo is to be recommended as furnishing excellent means of providing good succulent feed to tide over the dry spells." In so far as his work was done in Kansas, where pasture shortages are serious and where they have a long season for growing suitable soiling crops, his conclusions are especially favorable to silage.

One investigator, Lindsay (25), of Massachusetts, objected to silage for summer use when it was also employed during the winter season, because he felt that its acidity might cause harm if used constantly. In the light of present knowledge regarding silage, we can realize that such danger is remote. Later, Lindsay (26) suggests that not over 50 pounds of soiling should be fed daily because greater amounts are likely to induce scouring and decreased weight.

Kildee (22) of the Iowa station says that each dairyman must determine which feed to use according to his own conditions, but he recommends some soiling as permitting the greatest possible returns from a given area.

Henry and Morrison (19), believe that "on high priced land, where it is desired to keep as many animals as possible on a given area, such a soiling system may be the most profitable." They do not advise soiling where good pastures are available.

ADVANTAGES OF SOILING

First among the advantages of soiling is that this practice does not necessitate a silo. Some dairymen feel obliged to forego the expense of building a silo and many renters are unable to induce their landlords to invest in this equipment. Then again, silo filling is expensive; it requires considerable labor and it comes at a time when farmers are busy. The expense comes all at one time and unfortunately it is magnified in the minds of some farmers so that many silos have remained unfilled during the last few years.

For summer silage a silo of smaller diameter is demanded than for one to be used during the winter. The surface of silage spoils in the summer unless three or four inches are removed daily, whereas the removal of only one or two inches in winter is generally sufficient to prevent spoiling. Unless the silo is of small enough diameter to permit feeding off the required amount each day, considerable waste will result. Spoiled silage, even tho not especially harmful, is not readily eaten and much of it will be refused. The common practice is to have only one silo, but of sufficiently small diameter to be satisfactory for summer use. Such a silo can be built high enough for both the winter and summer supply. When the cows go to pasture in the spring the silage can be covered with chopped straw and oats and if soaked frequently it remains in good condition for the dry weather feeding.

The man with only five or six cows finds that his small herd does not justify a silo. Under such situations a soiling system readily adapts itself.

Another advantage of soiling over silage is the greater variety it furnishes the ration. The objection that continuous silage feeding is harmful because of its acidity need not concern us.

Soiling crops also help to solve the problem of essential mineral elements in the dairy cow ration, according to investigations by Hart and others (16) and (17). They found that the mineral supply required for high producing cows can be maintained in part by green feed. They observed that green feeds possess the anti rachitic D vitamin which increases the amount of calcium and phosphorus which cows can assimilate from their feed. Apparently the same feeds fed dry lack materially in this respect. Obviously, if some methods are available whereby cows can use more completely the mineral ingredients of the feeds for milk production rather than draw upon and deplete their own body stores, a part of the mineral problem is solved. At any rate, the use of green feeds in larger quantities offers possibilities in this phase of dairy cattle feeding and may reduce the necessity of buying expensive mineral supplements, the value of which has not yet been definitely established.

DISADVANTAGES OF SOILING

Practical dairymen generally prefer using summer silage because it entails less labor. The daily supply of soiling crops for the herd must be cut each morning and this requires time for a man and team. This station (14) found that to supply a herd of 40 cows on partial soiling it required two men and a team two hours daily. This is often difficult in rainy weather. Altho some (43) claim that it is unnecessary to cut the green crop more frequently than twice a week if it is scattered out to avoid heating, most men prefer to cut daily so that any danger of heating and spoiling can be avoided. If the feed does spoil it should not be fed because it causes far more difficulty with the cows than does ordinary spoiled silage. Additional labor is also required in seeding the small soiling patches at different times so the proper succession of crops may be obtained. At least five or six of these seedings each season are required. All this labor coming as it does during the busy season tends to discourage the practice.

A further difficulty with soiling is selecting the proper crops, timing the seeding date and determining the amount of land to seed. Failure in any one of these operations because of seasonal changes either results in a shortage of feed that is serious or an oversupply that can not always be used for hay and is then wasted.

When a summer silo is used the dairymen is independent of these seasonal changes because the feed is supplied the previous year. This steady supply adds stability and security so that a man can adjust his number of cows accordingly and insure against a feed shortage.

Silage possesses other advantages. It does not spoil with age nor lose any palatability because of maturity, as does soiling. It is constant in its composition while the soiling may vary in a few days from a washy soft feed to quite coarse mature plants. It is evident that summer silage is preferable, but many situations arise wherein silage feeding is impossible. Under such situations, a carefully planned soiling system induces greater and more economical production.

BENEFITS FROM THE USE OF SUCCULENT FEEDS IN SUMMER

Obviously the chief benefit that results from soiling crops as a supplement, or an entire substitute, for pasture lies in the increased amount of feed that can be secured. In addition to its being abundant, such feed is also palatable, succulent and nutritious. Unless sufficient good feed is available, milk production falls and it has been demonstrated again and again that lowered milk production leads to an increased cost per unit of production. Dairymen generally are operating on a very narrow margin between production cost and selling price and if the cost is allowed to rise the margin of profit soon disappears and the milking of cows must stop or proceed at a loss.

If the feed supply diminishes too greatly the cows also suffer and it is often impossible for them to recover during a subsequent lactation.

PREVIOUS WORK

A vast amount of experimental work has shown that increased feed can be secured by employing soiling crops. Investigators at the Pennsylvania station (1) found that soiling produced three to five times as much nutrients per acre as did pasture, but in spite of these yields they doubt the success of such a practice, owing to the labor involved. At the Iowa station (22) 37 cows were maintained on 19.5 acres of pasture and 8 acres of soiling crops in the season of 1911 when the farmers near Ames were allowing two or three acres of pasture per cow. In Kansas, Otis (34) found that a cow could be supported for 144 days on .71 acres in soiling crops while it took 3.63 acres of Kansas pasture. Results secured by Lyons and Haecker in Nebraska (28) and (29), show that two and three times more feed can be secured with soiling crops altho they say that the cows produced slightly more milk daily while on pasture. At New Jersey, Minkler (32) supported three cows on an acre of soiling while Voorhees and

Lane (37) of the same station fed at the rate of three and one-half cows for an acre. Zavitz (47) in Canada had to allow three acres of pasture for each cow, but 1.2 acres of soiling was sufficient.

Henry (18) at Wisconsin, secured two and one-half times as much milk from an acre of soiling as from an acre of pasture, and Carlyle and co-workers (7) obtained results of a similar nature.

At the Iowa station in 1891 and 1893 (43) and (44), it was found that cows "will give more milk than when feeding on a good bluegrass pasture." Jardine (21) reported three years' work at Oregon showing 15 to 20 percent increased production by feeding soiling crops during the summer months.

Moore (33) in Mississippi found that when the cows ate 41 pounds of soiling they produced greater yields than when they ate 3.4 pounds of cottonseed meal.

Goessman (15) of Massachusetts, in comparing soiling with hay, found that the former gave greater yields and more economical production.

Only two men have ever reported results not entirely favorable to soiling. Doane (10) in his work at Maryland found pasture more desirable than green corn and Linfield (27) at Utah secured \$6.50 greater returns per acre from pasture than with soiling. The number of animals Linfield used in his trial was too small; his allotment of animals was not the best and he says: "These results are not conclusive however, for the soiling crops."

A great deal of the work with soiling crops has been done with cows on a complete soiling system. That is, they did not have access to the pastures at any time and the soiling constituted the sole source of succulent feed. Nearly all dairymen recognize the value of some pasture in affording exercise and comfortable surroundings for the cows, but Washburn (39) at Vermont prefers the complete soiling to the partial. His explanation is that the cows did better when all their feed was furnished rather than when they were forced to travel for any part of it as when on pasture. It is conceivable that some pastures which were very short and lacked shade and water could prove detrimental to the cows even when liberally fed in the barn, but most men prefer some pasture for at least a few hours daily.

GROWING THE SOILING CROPS

One of the difficulties in employing a soiling system is to keep a continuous supply of green feed available. Seasonable influences are the most disturbing in maintaining this continuous supply. Probably five individual seedings in this section

are sufficient for a partial system. This number should prevent any possible shortage that might be due to the failure of any one seeding.

It is generally possible for the regular farm crops to provide a part of the soiling. Alfalfa and corn do this very satisfactorily. The other crops necessary can then displace a part of the small grains.

The land for special soiling crops should be located as close to the barn as possible and should be well prepared before seeding so that the greatest yields may be secured.

The rate of seeding largely determines the value of the crop for feeding. Too thin seeding results in larger, coarser plants that are not relished nor entirely eaten, while thick seeding gives a fine-stemmed, leafy, succulent feed that is consumed readily. Also the thick seeding generally increases the yield of feed and decreases the percent of weeds. Weeds not only reduce the amount of forage, but also impair its value.

The harvesting of soiling crops is difficult for the feed is heavy, it often is wet and the fields muddy. When possible a mower should be used for cutting. The only approved soiling crop that cannot be satisfactorily cut with a mower is corn. A binder should be used for corn unless a very small amount is needed daily and then corn knives are satisfactory.

FEEDING SOILING CROPS

Some men prefer to feed their soiling in the barn, others in the pasture or lot. A long rack in the pasture or lot is the more convenient method and is cheaper. Sometimes the feed is merely scattered along the fence. This method is wasteful because the cows tramp and foul the feed. It also dries too rapidly, becomes unpalatable and large quantities are refused. The chief disadvantage of the rack is that it is often too small and a few of the "boss" cows deprive the others of sufficient feed.

Supplying the feed in the barn takes more labor but, on the whole, is the best method. This wastes practically none of it. Feeding in the barn has another advantage. If the cows are brought in from the pasture during the middle of the day they can be fed the soiling immediately and one feeding a day is sufficient where a partial system is employed.

If the cows are sprayed to relieve them of flies and if the barn is darkened, they will be more comfortable than in the pasture and will produce more abundantly.

With the possible exception of corn, all soiling crops can be conveniently fed in the manger. Chopping the corn improves it and is a satisfactory plan for large herds where considerable amounts of the crop are fed.

If the cows are not on pasture at all, two feedings of soiling daily are necessary. The times for feeding are not important, except that they be regular. Most of the crops can be fed just before or even during milking without having any serious deleterious effect on the flavor of the milk.

The amount of soiling to feed depends largely on the individual cows. They should receive all they will consume without waste. If on good pasture, they will consume about 40 or 50 pounds daily, while if no pasture is used, they will eat as much as 75 or 100 pounds. If the feed be wet, smaller amounts should be allowed for it may cause scours.

CROPS SUITABLE FOR SOILING

It is imperative that the crops for a soiling system be selected carefully. Unless the climatic and soil conditions are favorable to a certain crop, it must be omitted. Abundant yields are necessary. Under conditions which prevail thruout this section a wide variety of crops are possible because the climate and soil are favorable to a great many plants.

The cost of seed and the rates of seeding vary considerably for different crops. These factors must be considered for they may contribute greatly toward success or failure. Naturally the crop which is the cheapest is to be advised if its value as a feed is established. Its cost will be determined by the cost of seed, the yield, and the ease of harvesting.

In order that the proper succession of crops can be secured, the rate of growth for these crops must be known. The more rapid growing plants are more desirable. The time for harvesting can be determined with greater accuracy earlier in the season and they can also be removed and followed by other crops the same season. An objection to many of these quicker growing crops is that they also have a limited period during which they can be used. Plants which furnish more than one cutting a season are desirable. It is important that crops be grown which will be most palatable to the cows. Also, no crop should be fed which will have a harmful effect upon the cows nor upon the milk.

EFFECT OF CROPS UPON MILK FLAVOR

A great many succulent feeds commonly used for dairy cows convey a flavor to the milk that is discernable. This is true when cows are turned onto luxuriant pastures in the spring and consume large quantities of the grass. This flavor is noticeable and often undesirable because of its contrast to that of milk from cows on dry feed. By bringing the cows onto grass gradually and allowing them a fill of hay each morning so that they eat less grass, the change can be made and even the most fastidious customers fail to note the flavor. Even tho this

flavor is noted, it is not sufficiently serious to be undesirable for more than a few days and one who consumes the milk soon becomes accustomed to it.

Gamble and Kelly (13) found that corn silage affected the milk even tho fed immediately after the previous milking. Silage from legumes similarly fed had even a more pronounced effect. Babcock (3) observed off flavors when turnips were used. Their effect was particularly noticeable in the cream.

Similar effects have been noted when various soiling crops are used. Babcock (2) found that the injudicious use of green corn and green alfalfa induced a flavor and an odor in the milk. He recommended their use after milking.

When Day (9) at Ontario used rye, the butter scored 35 points for flavor while with alfalfa the score was 40. Wilson (45) in Iowa especially commends green corn because of the excellent flavor he noted in the butter when it was fed. He ranks soy-beans with corn in this respect.

Rape is the one crop which is quite generally condemned because of its deleterious effect upon the flavor and odor of the milk. Lane (23) and (24) used a great many crops at New Jersey, and he found that rape was the only one that was unsafe to feed. He advises care with all green feeds however. Wilson (44) and Carlyle (7) are in agreement with Lane as regards the use of rape. Watson and Mairs (40) in their earliest work at the Pennsylvania station, found no resultant flavor from the first cutting of rape, but the second cutting was accompanied by a flavor attributed either to the rape or the individuality of the cows. They later (41) and (42) state that rape may impart flavors but they are not at all positive. Mairs (31) a few years later reported that he did not find a disagreeable flavor from its use.

In view of results secured at various experiment stations, it is obvious that rape should be avoided in a soiling system because of undesirable flavors it may impart to the milk. The other green feeds are safe. They may impart flavors or odors which are not entirely agreeable for a time, but they are not permanent and remain only a few days.

EXPERIMENTAL METHODS USED

During a period of eight years, quite careful trials were in progress at the college dairy farm to determine the practicability of soiling systems and the best plans for operating them. A part of the results secured have been reported previously in Iowa Station Bulletin 187, which is now out of print. In the feeding work the entire milking herd was used. No effort was made to follow a complete soiling system as the cows were on

pasture every day of the season. The pasture land was rolling and the soil contained a considerable amount of gravel and rocks. During the earlier years of the trial the pasture was poor but later it was built up by good management into an excellent pasture. The pasture consisted of 20 acres and when supplemented with soiling crops it supported 40 to 50 cows each season.

In growing the crops very careful consideration was given to their practicability for soiling purpose in this section of the country. The cost for all items entering into the production of the crops has been included. These items begin with the preparation of the land and continue until the feed is in the barn. They include man labor, horse labor, cost of machinery, rent of land, seed and manure. Of course the cost of these items varies under different conditions and in different seasons, but man labor has been charged at \$55.00 per month, horse labor at 10 cents per hour and rent of land at \$6.00 per acre.

The same scheme was used in obtaining the costs for pasture. In this case horse and man labor were involved in reseeding, disking, mowing and spreading manure. The rent of the land for pasture also includes the fence building and upkeep.

LEGUMINOUS CROPS

ALFALFA

Alfalfa is one of the good soiling crops and is superior to all other legumes. During the eight years covered by this trial, alfalfa was used each year except in 1918. This crop owes its importance partly to its high protein and calcium content. This is an especial recommendation for all the legumes, which Phelps (35) and (36) at Connecticut found to be about 12 per cent more valuable than the cereals. Alfalfa is quite palatable and in tests cows readily consumed 35 pounds daily after they had become accustomed to it. As much as 70 pounds daily was fed certain cows.

One of the outstanding advantages of alfalfa for soiling is its dependability. It can constitute one of the main farm crops and only as much as desired need be cut for soiling. The rest of the crop can be cut for hay and thereby furnish one of the most valuable feeds. The crop is permanent for three or more years; it is quite resistant to drouth and since three crops are easily secured, it works nicely into any soiling system. In certain arid regions where four or five cuttings of alfalfa per season are secured and where pasture or other green feeds are not dependable, alfalfa can serve as the sole source of succulence. Even in this section if sufficient acreage be available it may be depended upon quite largely for the entire season from early in June until September 20.

This latter plan is not recommended, however, for it often induces too frequent cutting. This weakens the plants, causes them to die out and admits weeds to the field.

The best results in this trial were obtained when the alfalfa was seeded the previous year with oats* as a nurse crop. Eighteen pounds per acre of alfalfa seed were used with one and one-half to two bushels of the oats. These oats were cut for hay while in the milk stage in late June or early July. The alfalfa was not cut until the following season. The first cutting of alfalfa was generally obtained from June 10 to 20 and

the second from July 5 to 15. An average of eight tons of green feed per acre secured from the first cutting and four tons from the second. In some years the third crop of alfalfa was also used. This crop was secured from August 20 to 25 and yielded about two tons per acre, making the total yield 14 tons for the season. The costs per ton for this feed were quite high. The first crop cost \$3.00 per ton, the second \$4.50, while the third cost \$5.00, with an average for all of \$3.98.

The chief disadvantage found for the alfalfa was that the plants blossom and get coarse too rapidly. If cut before the bloom or crown shoots appeared, the plants weakened. If cutting was delayed past full bloom, the feed was rather coarse. Since the time between these extremes was only about 10 days, the feeding period was limited.

*The best variety of oats for this purpose is Iowa 105. Barley or winter wheat can also be used very satisfactorily as the nurse crop, but spring wheat should never be used.

RED CLOVER

Red clover has a wider distribution thruout the United States than any other legume. Yet it is not especially valuable as a soiling crop. It grows quite rapidly and the stems quickly become woody so that its period of usefulness is short. It can be expected to yield only about 10 tons per acre and in this respect is inferior to alfalfa. Also, its protein and mineral contents are lower than those of alfalfa. The proper stage of growth for cutting red clover is just as the first blossoms appear, for at this time more protein and less fiber are secured. When grown alone, red clover frequently lodges and makes harvesting quite difficult. The first cutting of clover is preferred to the second. While the latter may be used for soiling it is better to cut it for hay or for seed.

SWEET CLOVER

Sweet clover is only fairly satisfactory as a soiling crop. It grows so rapidly that the stems become coarse within a few days and its feeding period is short. In spite of these objections, it has great favor among some dairymen.

During these trials sweet clover was used for only one season. It was seeded the previous spring at the rate of 15 pounds per acre along with one and one-half to two bushels of oats. The first cutting from June 7 to 17 yielded only five tons per acre and the second from July 24 to 27 only two tons. The cost of the feed in the barn was \$2.80 for the first cutting and \$3.60 for the second. Greater yields than these, amounting to 10 to 15 tons per acre, have been reported by some, but in this trial the yields averaged about half those of alfalfa.

A criticism frequently directed against sweet clover, that it is unpalatable, was not especially serious in this trial. The cows did not relish it at first, but after a few days they ate it as readily as they did alfalfa. The cows consumed 35 pounds of the first cutting per head daily; they received 39 pounds of the second cutting.

From our experience with the low yields and the difficulty in handling the crop at the right time, sweet clover is not especially recommended for soiling. However, if one has sweet clover on his farm and wishes to use it more efficiently than is possible by pasturing, he will find in it a very good feed that can be produced at reasonable costs.

SOYBEANS

Soybeans are one of the most popular crops grown in Iowa. They have a high protein content and are more easily grown than alfalfa, being less susceptible to acid soils, hot weather or drouth. Soybeans are valuable as a catch crop if alfalfa or clover dies out and they may

be seeded in Iowa as late as June 15. They were used in these trials two seasons with fair success.

The Peking variety is one of the best for soiling purposes. It yields more foliage than some of the other varieties and its small seeds reduce the rate and cost of seeding. In one trial when the soybeans were drilled at the rate of 45 pounds per acre, the yield was five and one-half tons at a cost of \$3.00 per ton. When put in 42-inch rows, the yield was three tons at a cost of \$4.60 per ton. Soybeans drilled in 20-inch rows yielded six tons at \$2.70 per ton.

The soybeans were somewhat unpalatable when first fed, but this is a general experience with most green feeds. The cows later relished them and as much as 73 pounds daily were eaten.

There are certain objections to the use of soybeans for soiling. When the beans are grown in rows so they can be cultivated, the yields and quality of feed are reduced. When sown with the grain drill so that the yield can be increased, difficulty is encountered in keeping the weeds down. Furthermore, with any method the crop is difficult to cut and load without becoming mixed with a great amount of soil. This is especially disagreeable in wet weather and may induce digestive disturbances among the cows.

Results of other trials by the Farm Crops Section (20) of this station seem to indicate that quite close drilling and a high rate of seeding followed by frequent harrowing give the best results. The yields are thereby increased, the quality of the feed is improved, the weeds are controlled and the green feed can be raked up with less dirt adhering.

CANADA FIELD PEAS

This crop is not recommended for soiling when grown alone for the yields seldom exceed seven tons per acre and the seed is too expensive. The plants are small and lodge quite badly. However, Canada field peas grow readily in Iowa and yield a very palatable feed. They are more successfully used in a mixture such as with oats.

COWPEAS

When they were grown alone, cowpeas were not found to be desirable. They are more adaptable to southern climates and do not give the yields of feed that can be secured from soybeans. Their use for soiling in this section should be confined to a mixture with some other crop such as amber cane. Tests made by the Farm Crops Section with cowpeas and soybeans in comparison, both alone and in mixtures, indicate that the soybeans are to be preferred.

UNSUITABLE LEGUMINOUS CROPS IN IOWA

Other than the legumes just recommended, there are some that are frequently suggested for soiling purposes. Most of these are adapted to certain climates but in Iowa they must be displaced by one or more of the more satisfactory legumes. Among those unsuited to our conditions are alsike, mammoth red and crimson clover, sainfoin, flat peas and vetches.

NON-LEGUMINOUS CROPS

CORN

Dent corn is especially valuable for soiling because it yields abundantly and is palatable. Vorhees (38) says, "There is no crop that is equal to corn for forage purposes." Like all the non-leguminous crops, corn lacks somewhat in protein content.



Fig. 1. Amber cane gave very good results. It yielded abundantly and made the cheapest feed grown. When seeded thickly the quality of the feed was excellent.

As the leading crop in Iowa, it frequently is utilized for soiling during the latter part of the season. The harvesting of corn entails some difficulty as does also its feeding, but its availability makes it popular. There is some danger in feeding green corn too early in the summer but after August 1, in most seasons, it may be used with safety until it matures or gets frosted.

In these trials corn was used during three seasons and gave good results. The yields obtained were from 9 to 12 tons per acre and the cost was \$2.70 per ton. The amount of corn allowed the cows daily was limited so that they were forced to clean up the stalks. The average daily amount per cow was 38 pounds.

SWEET CORN

Sweet corn is more palatable than dent corn and if the larger varieties are used it gives nearly as big yields. It stays green longer and it is finer in quality. Its smaller stalks result in less waste and less difficulty in feeding. Where the sweet corn is grown for canning, it furnishes a good feed even after the ears are removed.

OATS

The oats in these trials were generally grown with Canada field peas. In the one season when they were used alone a field sown for grain began to lodge and to save them they were fed as soiling. Seven tons of feed per acre were obtained at a cost of \$2.90 per ton. They thus make quite a cheap feed but were not especially palatable. However, one who feels that he cannot afford the expense of the Canada field pea seed can use the oats alone with good results for an early season feed.

SUDAN GRASS

In this state sudan grass can be employed successfully for soiling. It does not rank high among the crops for this purpose, but serves well as a catch crop when some other one fails. It may be sown as late as July 25, but earlier seedings are safer. It yields very well, 11 tons having been secured at this station at a cost of \$4.00 per ton. The rate of seeding was 20 pounds per acre.

Sudan is fairly palatable but as it approaches maturity it dries rapidly, becomes fibrous and loses its value for soiling.

Some cases have been reported wherein sudan grass, like amber cane, caused poisoning as a result of the development of prussic acid following frost. These cases seldom occur however, and need cause very little alarm.

WINTER RYE

Among the lesser cereals rye has been used most for soiling purposes. Its merit lies in the fact that it can be used earlier in the season than any of the other crops commonly grown. It yields only about five or six tons per acre, is of fair palatability but is said by some to have an undesirable effect upon the flavor of the milk.

FOX-TAIL MILLET

The chief advantage of the millets over other soiling crops is that they are quick growing, either with very early or very late seeding. Under some conditions they can be harvested 40 or 50 days after seeding.

The yields vary from 10 to 14 tons and the best results are obtained with the thicker seeding such as three or four pecks per acre.

There are many varieties of millets. They include Common, German, Hungarian and many others. The Common millet yields the best quality of feed, while the German variety is coarse and not so palatable.

Millets are not popular as farm feeds and since the other available crops in this part of the country are more desirable, the necessity of using the millets for soiling is infrequent.

AMBER CANE

Amber cane is a valuable crop for soiling. It is extremely palatable and cows consume large quantities of it, up to 70 pounds daily being common. It can be used late in the season until frost comes, and matures slowly so that it can be used over a long period without becoming woody. It was used quite extensively for three years in this work. During the last year in an effort to simplify the system as much as possible sorghum and Canada field peas constituted the sole special crops used. For best results seeding should be thick, using 80 to 100 pounds, for this insures not only larger yields but a finer quality of feed, which is readily eaten with little waste.

Three or four seedings of amber cane per season were made between May 10 and July 10. The crops were cut between July 20 and the first of October.

In 1918 a late sowing on July 9 at 98 pounds per acre yielded 15 tons. This seeding was made on a wet spot in the corn field where the corn was thin. It was used during the first of September and was the cheapest feed secured during the eight years' work. The cost was \$1.46 per ton. A late seeding in 1917 at the rate of 66 pounds per acre yielded only seven tons at a cost of \$2.85. The average yield for amber cane on all plots used was 12 tons and the cost was \$2.00 per ton. This cost was lower than for any other crop.

There is one disadvantage in the use of amber cane. It lies in the danger of prussic acid poisoning. This is serious chiefly on second growth

or after the plants have been checked by such agencies as frost or drouth, but with care in avoiding the use of the cane, if these unfavorable conditions arise, no difficulty need be experienced.

MIXED CROPS

Suitable mixtures of crops are quite desirable for soiling. A legume and a non-legume generally comprise such a mixture and each one thus contributes some desirable feature to the feed. Even tho the mixtures make good feeds, there are practical difficulties in growing them so that they will probably never become extremely popular. The number of such mixtures suited to the conditions of this state is limited.

OATS AND CANADA FIELD PEAS

This mixture is quite widely used. Both the oats and peas have a wide distribution thruout the country and when grown together, the limitations of each are quite satisfactorily overcome. They do not lodge and they furnish better feed than when grown alone.

One of the difficulties with this mixture, as with the others, is to get the seeding time adjusted and the varieties selected so that the plants are ready to harvest at the same time. The oats generally tend to ripen first.

The time to cut is when the oats are in the milk stage and the peas have filled the pods.

As has been previously suggested, the price for the seed of the Canada field peas is nearly prohibitive and other crops may have to be relied upon.

This crop was used in all of the eight years covered by these trials. Three seedings a year were made between April 5 and May 10. For the earlier seedings an early variety of oats was used while for the later seedings a later variety was used. This mixture is an early season crop and was harvested between June 15 and August 1. The best results were secured when one and one-half bushels of each seed were used. The largest yield secured in any season was 15 tons at a cost of \$2.07 per ton. This crop was seeded April 5 and was fed during the latter part of June. It is interesting to note that an adjoining field of this crop seeded the same year on April 29 and used in July gave a yield of only five tons per acre and cost \$5.21 per ton. It was a common experience to secure much lower yields with the later seedings. The average yield secured thruout the trials was six and one-half tons. The cost was \$4.36.

When the crop was cut at the proper stage it was very palatable. The cows would eat 60 to 70 pounds daily, but the amounts fed were generally limited for it was used in June and July before the pastures got short and dry. When cutting was delayed till the oats got too ripe they were not at all relished.

AMBER CANE AND COWPEAS

Amber cane and cowpeas were used as a mixture during four years of this trial. This mixture proved to be an excellent feed and it can often be used to advantage in place of the amber cane alone. For best results the Whip-poor-will or New Era varieties were used. These made a fine quality of feed and the mixture proved very palatable, about 45 pounds daily having been fed. Seeding of this mixture can be done early in the season. One year three seedings were made, one in the middle of May, the other a month later and the third early in July. They were then ready to feed from the first of August to the middle of September. The seeding was made at the rate of one bushel of the cowpeas and 35 pounds of cane. The yield per acre for this mixture for all seasons averaged 10.6 tons at an average cost of \$2.24 per ton.

SUDAN AND SOYBEANS

While no feeding trials have been conducted to determine the value of a mixture of sudan and soybeans, such a mixture has possibilities. The palatability of the feed remains to be seen, but it would probably be fairly well relished. From the standpoint of producing an abundance of feed, the mixture is excellent. The Farm Crops Section of this station received excellent yields when 60 pounds of Manchu or Peking soybeans were seeded with six pounds of sudan. The medium early maturing varieties of soybeans proved better than the later ones for their pods were partly filled at the time when the sudan was ready to cut.

OTHER MIXTURES

Various other mixtures have been recommended in different sections of the country. Oats and common vetch are among these. The vetch is not so satisfactory even as the Canada field peas in the mixture for the vetch seed is too expensive. Barley and Canada field peas have also been used. The barley ripens earlier than oats, thus adding to the difficulty already mentioned. Winter rye and hairy vetch are good for early spring but the cost of the vetch seed hardly justifies its use. Cowpeas and corn are often recommended, especially for the South but for Iowa, soybeans are superior to the cowpeas. This mixture gives an abundance of good palatable feed.

Clover and timothy can be used, but each crop is inferior for soiling and the mixture is little better. The yields are low, the feed is not especially relished and it is more satisfactory to let the crop mature for hay.

RESULTS SECURED

An important phase of the work reported here is the comparison obtained between the practice of depending upon pastures alone and that of supplementing limited pastures with soiling crops. The scheme employed in these trials was to use only 20 acres of pasture for the 40 to 50 cows.

In table I are shown the acreages in pasture and soiling each season, the number of cows supported and the total acreage required per cow for the summer seasons when a partial soiling system was employed.

From this table it is observed that each cow consumed an average of 1.92 tons of soiling per season. Thruout the entire trial

TABLE I. AREAS USED FOR PASTURE AND SOILING

Year	No. of cows	Pasture acres	Soiling acres	Pasture days	Soiling days	Soiling per cow tons	Total area per cow acres
1911	40	20	9	165	127	1.47	.73
1912	41	20	6	170	98	1.42	.63
1913	42	20	10	167	108	1.26	.71
1914	42	20	10	165	108	1.85	.71
1915	40	20	10	177	116	2.14	.75
1916	40	20	20	173	97	1.87	1.00
1917	47	20	22	152	126	3.50	.87
1918	51	20	11	130	57	1.33	.61
Average	42	20	12	162	105	1.92	.76

TABLE II. SUMMARY OF SOILING CROPS GROWN ON IOWA STATE COLLEGE DAIRY FARM

Crop	Approximate date of sowing	Rate of seeding per acre	Approximate date of harvesting	Yield per acre tons	Cost per ton	Feed per cow per day lbs.
Alfalfa	Previous year	18 lbs.	June 10-20	8	\$3.00	35
Alfalfa	Previous year	18 lbs.	July 5-15	4	4.50	40
Alfalfa	Previous year	18 lbs.	Aug. 20-25	2	5.00	30
Sweet Clover	Previous year	15 lbs.	June 5-20	5	2.80	35
Sweet Clover	Previous year	15 lbs.	July 25-30	2	3.60	40
Soybeans	May 25	50 lbs.	Aug. 25-Sept. 15	5	3.50	55
Amber cane	May 15	70 lbs.	July 20-Aug. 20	12	2.25	70
Amber cane	June 20	70 lbs.	Aug. 15-Sept. 20	12	2.00	70
Amber cane	July 10	70 lbs.	Sept. 1-Oct. 10	12	2.00	70
Oats	April 5	1½ bus.	July 10-15	7	2.90	45
Corn	May 10	9 lbs.	Oct. 1-10	10	2.70	40
Sudan grass	May 25	20 lbs.	Aug. 25-Sept. 10	11	4.00	40
Oats and Canada field peas.....	April 5	1½ bus. oats and 1½ bus. peas	June 15-July 5	6	5.00	40
Oats and Canada field peas.....	April 20	1½ bus. oats and 1½ bus. peas	June 30-July 10	5	4.50	50
Oats and Canada field peas.....	May 5	1½ bus. oats and 1½ bus. peas	July 10-25	5	4.00	60
Amber cane and cowpeas.....	May 25	35 lbs. cane, 1 bu. cowpeas	Aug. 1-30	9	2.50	45
Amber cane and cowpeas.....	June 25	35 lbs. cane, 1 bu. cowpeas	Aug. 15-Sept. 5	13	2.00	45
Amber cane and cowpeas.....	July 5	35 lbs. cane, 1 bu. cowpeas	Sept. 1-20	9	2.00	45

the average cost of a ton of soiling was \$2.71. The season's cost for soiling for each cow was therefore \$5.20. The average cost of pasture for each cow for a season was \$3.18, or a little under two cents a day. The total cost for both soiling and pasture is \$8.38. The average acreage required for the season's supply of succulent feed for each cow was just .76 acres or little more than three-fourths of an acre. Had these cows been forced to subsist upon pasture alone, without the soiling, two or three acres would have been required. This is the allowance generally made in this state. This much pasture would have cost \$12.00 to \$18.00 at least and there is therefore a considerable saving thru the use of the soiling crops.

In table II are presented the data secured from the different crops. This material is a result of the eight years' trials and includes most of the crops used. Those crops excluded from the table were found undesirable. Even some of them which are included are not especially recommended, but may be used with some success under particular conditions.

PLANS FOR SOILING SYSTEMS

From the results secured, it is possible to suggest plans that may be followed. Those suggested are of course flexible and can be greatly modified to suit especial cases. If a change from the outline is desired, a reference to table II will reveal some of the possibilities.

The acreages given are for a herd of 15 cows on a partial system when 10 acres of pasture are also available. If more pasture than this is to be used, the prescribed areas for soiling can be reduced. If no pasture is available and a complete soiling system is necessary, the acreage should be increased by 50 percent.

Table III gives the outline when alfalfa and corn are available. It depends on the use of amber cane and oats and Canada field peas. These crops were found to be the best of all crops tried.

If the price of the seed for the Canada field peas is too high, it may be omitted and the oats alone used. In doing this the rate

TABLE III. A PLAN WITH ALFALFA

Crop	Area acres	Approximate date of sowing	Approximate date of harvesting
Alfalfa, 1st cutting.....	$\frac{1}{2}$	Previous year April 5	June 10-20 June 15-July 5
Oats and Canada field peas.....	1	April 20	June 30-July 10
Oats and Canada field peas.....	$\frac{1}{2}$	Previous year May 5	July 5-15 July 10-25
Alfalfa, 2d cutting.....	$\frac{1}{2}$	May 20	July 20-Aug. 20
Oats and Canada field peas.....	$\frac{1}{2}$	Previous year May 10	Aug. 20-Sept. 1
Amber cane	1	May 10	Sept. 1-Sept. 20
Alfalfa, 3d cutting.....	1	May 20	Sept. 15-Oct. 15
Corn	1		
Corn	1		

TABLE IV. AN OUTLINE WITHOUT ALFALFA

Crop	Area acres	Approximate date of sowing	Approximate date of harvesting
Oats and Canada field peas.....	1	April 5	June 10-July 5
Oats and Canada field peas.....	1	April 25	July 1-25
Amber cane	1½	May 20	July 20-Aug. 25
Amber cane	1½	June 25	Aug. 15-Sept. 15
Corn	1	May 10	Sept. 10-Oct. 15

of seeding should be increased to two or two and one-half bushels, but the acreage necessary can remain the same. In this system as well as in the next one given, the amber cane may be mixed with soybean or cowpeas to advantage under many conditions.

With this outline the oats and peas are available between the first two alfalfa cuttings. Then they are used again and amber cane is introduced while the third crop of alfalfa is growing. Following this crop, the earliest corn can be used early in September and for the rest of the season the corn planted last is available. When no alfalfa is available, an outline for crops such as shown in table IV is suggested.

This system would not be so desirable as the previous one for it prolongs the time during which the crops would have to be fed. Starting the feeding as soon as suggested would reduce the yield while continuing too long would reduce the quality. This criticism can be overcome however, by introducing a third sowing each of the oats and Canada field pea mixture and of amber cane.

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